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INTRODUCED LEAF BEETLES OF THE MARITIME PROVINCES, 2: THE CEREAL LEAF BEETLE *OULEMA MELANOPUS* (LINNAEUS) (COLEOPTERA: CHRYSOMELIDAE)

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Abstract.—Voucher specimens of the cereal leaf beetle, *Oulema melanopus* (Linnaeus), from the Maritime Provinces of Canada were examined. This important cereal pest is newly recorded from Prince Edward Island. Most populations established in the Maritime Provinces of Canada probably originated from southern Ontario where *O. melanopus* was first discovered about 1965. Historical information demonstrates that the beetle spread northeastward by natural means and reached Prince Edward Island by 1994. An alternate source of introduction may have been the port of Halifax where *O. melanopus* has been intercepted in cargo originating from Italy. However, it is not possible to distinguish beetles originating from southern Ontario from those introduced directly into Halifax. The introduction of the species into the Canadian Maritimes was probably either domestic or from adjacent portions of the United States. *Oulema melanopus* is likely to continue to spread slowly by natural means throughout Canada. Host availability and climate change are likely to assure survival and establishment in new environments despite phytosanitary measures. Introduction of biological control agents and resistant cereal varieties are likely to maintain populations at or below economic thresholds.

Key Words: Coleoptera, Chrysomelidae, Criocerinae, *Oulema melanopus*, cereal leaf beetle, Canada, Maritime Provinces, adventive species, quarantine pest

The cereal leaf beetle, *Oulema melanopus* (Linnaeus, 1758), is an adventive Palearctic leaf beetle that is now widely established across much of the United States except for the southwest (NAPIS 2005, Riley et al. 2003) and Canada (Campbell et al. 1989, LeSage 1991, Olfert et al. 2004, CFIA 2005).

In the Old World, it is found throughout most of Europe, in North Africa, and across much of Asia from China, Mongolia and central Siberia west through Iran and the Caucasus to Turkey and south to Israel and Syria (Haynes and Gage 1981, Olfert et al. 2004).

In Europe, however, *O. melanopus* has often been mistaken for the closely related *O. duftschmidi* (Redtenbaker, 1874). Berti (1989) discussed the external

morphology and genitalia of both species in detail. Both are sympatric, but *O. melanopus* appears more northern in distribution whereas *O. duftschmidi* is more Mediterranean and Oriental. Consequently, the possibility that *O. duftschmidi* has also been introduced into North America is not excluded, but it has not as yet been demonstrated.

Hitherto, most of the available information on *O. melanopus* in Canada consisted of short summaries resulting from Canadian agricultural pest surveys or plant quarantine pest monitoring. In this study, we provide original information obtained directly from voucher specimens of older records, or from new material not previously reported in publications. The dispersal patterns of *O. melanopus* in the Maritime Provinces of Canada are also discussed.

Historical Review

Oulema melanopus is an invasive pest of small grains and was probably introduced into North America between 1947 and 1949, although it was not identified until 1962 in Berrien Co., Michigan, where it caused significant damage to oats (*Avena sativa* L., Poaceae) (Haynes and Gage 1981). *Oulema melanopus* may have gained entry into the United States via straw originating from Europe that was used as packing material for shipments of brick, although the exact pathway is unknown (Dobesberger 2002). In 1960, at Muskegon, Michigan, *O. melanopus* was found on plants in the trunk of a passenger car originating from Europe (Spears 1964). Numerous interceptions in the USA have been made since the earliest known record in 1936 at Baltimore, Maryland (Spears 1964). Despite pest control and strict quarantine measures (i.e., treatment of hay, straw, corn and sod for movement outside of a quarantine zone), *O. melanopus* continued to spread by natural and various man-made means throughout the Great Lakes Region between 1962 and 1979 (Haynes and Gage 1981).

In Canada, all life stages of the beetle were found for the first time in May 1965, near Harrow, in southern Ontario (Brown 1966). Within two years, the beetle had already infested several fields of Essex County. For this reason, it was expected to spread mostly in a northeasterly direction (McClanahan et al. 1968). To the northwest, the dispersal may have been assisted by additional foreign sources of adults since specimens were intercepted in 1969 at Thunder Bay (Ontario) from agricultural machinery (combines) originating from Germany (Straby 1971). To the east, *O. melanopus* reached the Ontario/Québec border in 1970, and was suspected to be established in Québec (Manson and Boyce 1970). In order to verify this hypothesis, the Division of Plant Protection of Agriculture Canada, Québec section, made several surveys in the southwest of the province in 1972, but no eggs, larvae, or adults were detected although minor damage was observed in some fields of the Vaudreuil-Soulanges counties, west of the Island of Montréal (Dandurand 1976). The quarantine measures ordered by the Division included all Metropolitan Montréal and Vaudreuil-Soulanges counties (Cardinal 1974, Caron 1975). Despite these measures, all life stages of *O. melanopus* were found in 1975 in several localities along the north side of the Ottawa River, from Lachute to Île-aux-Alumettes (Dandurand 1976). Following a small survey in 1981, it was established that the beetle occurred south of the St. Lawrence River from the Ontario border eastward to Nicolet, Drummondville, Acton Vale, and Bedford (Anonymous 1981). In 1982, an attempt was made to define the eastern border of the infestation in Canada. Scattered specimens were found in Richmond, Sherbrooke, and Stan-

stead counties; the map given in the report also included Québec City (Anonymous 1983). In 1983, 22 fields were checked between Québec City and Mont-Joli, and within the Matapédia Valley; after this survey, *O. melanopus* was considered to have extended its eastern range to Mont-Joli, in the Gaspé Peninsula, and to the border of New Brunswick (Anonymous 1983).

A survey carried out by the Plant Health Division of Agriculture Canada, in 1984, in wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L., Poaceae) and oat fields of Grand Falls, St. Quentin, and Woodstock, New Brunswick, did not detect the cereal leaf beetle (Anonymous 1986). Larvae of the beetle were collected for the first time in 1988, in grain fields located along the St. John River Valley between Hartland (Carleton Co.) and Edmundston (Madawaska Co.) (Finnamore 1988a, Anonymous 1989). It was first detected in Maine (USA) in Ft. Kent, New Canada, and Presque Isle in northern Aroostock Co. (adjacent to Québec and New Brunswick) in 1986 (Dearborn and Donahue 1993).

Oulema melanopus was first noticed in Kings County (Nova Scotia) in 1995, became widespread in 1996, and it was necessary to use chemical controls in 1997 (Crozier 1997a, 1998). *Oulema melanopus* has since been intercepted in Nova Scotia (Halifax) in a wooden container originating from Italy (CFIA 2001).

The search for biological control agents started as early as 1963. Four hymenopteran species were immediately established in Michigan (Haynes et al. 1974): a mymarid egg parasitoid, *Anaphes flavipes* (Foerster), an eulophid larval parasitoid, *Tetrastichus julis* (Walker), a solitary ichneumonid, *Diaparsis carinifer* (Thomson), and a larval ichneumonid parasitoid, *Lemophagus curtus* (Townes). Only *T. julis* was released in Canada, and the targeted area was south-central Ontario (Hartcourt et al. 1977). In 1975, only one year after the parasitoid releases, parasitism rate varied from 15% to 95% (Ellis et al. 1979). In the late 1980s, parasitism held the cereal leaf beetle at a low level throughout Ontario except in west Norfolk County (Bereza 1990). In New Brunswick, *T. julis* was already present when the beetle populations were surveyed (Finnamore 1988b). In Colchester Co. and Kings Co., Nova Scotia, larval parasitism by *Tetrastichus julis* varied from 5 to 50%, and 0 to 12.7% respectively (Crozier 1997b).

These parasitoids succeeded in keeping populations of the cereal leaf beetle in the United States at or below economic thresholds (USDA-APHIS-PPQ 1995). In the absence of natural enemies, yield losses could reach 55% in spring wheat, and 23% in winter wheat. Up to 75% yield loss could be observed in oats and barley (USDA-APHIS-PPQ 1995). The successful introduction of parasitoids into *O. melanopus* populations, which contributed to their decline, probably led to the deregulation of this pest by USDA officials in 1973 and discontinuation of these biological control programs in 1979 (USDA-APHIS-PPQ 1995).

In 1984, *O. melanopus* was reported in Utah and by 1999 had spread to the neighbouring states of Montana, Oregon, Washington, Idaho, Colorado, and Wyoming (Hammon and Peairs 2003). In the Pacific Northwest, *O. melanopus* was found to be a serious problem where the early stages of barley crops were attacked (Buntin et al. 2004). As a result of this western invasion and observation of increased damage compared to central and northeastern North America, APHIS reintroduced its biological control program for *O. melanopus* in 1993 (USDA-APHIS-PPQ 1995). Despite these biological control efforts, *O. melanopus* has been found in the Creston Valley in neighboring British Columbia, Canada in 1998 (CFIA 1999), and in the East Kootenays in 2002

(CFIA 2002). *Oulema melanopus* has since spread to Alberta in 2005 (County of Lethbridge and the Municipal District of Taber) (NAPPO 2005).

Oulema melanopus has been recorded as feeding on a wide variety of grasses in the Poaceae including species in the genera *Agrostis*, *Alopecurus*, *Arrhenatherum*, *Avena*, *Brachypodium*, *Bromus*, *Dactylis*, *Echinochloa*, *Elymus*, *Festuca*, *Hordeum*, *Lolium*, *Oryza*, *Panicum*, *Phalaris*, *Phleum*, *Poa*, *Secale*, *Setaria*, *Sorghum*, *Triticum*, and *Zea* (Campbell et al. 1989, Clark et al. 2004). According to Dandurand (1976), oats are the ideal host, whereas Caron (1975) reported that spring wheat was preferred when he made mid-June surveys in cereal fields of the southeast region of Montréal. Surveys made in Ontario in 1970 ranked oat, barley and wheat in order of preference (Anonymous 1970).

Methods and Conventions

In the course of ongoing research on the Coleoptera fauna of the Maritime Provinces of Canada, specimens of *O. melanopus* in various regional collections, as well as, in the Canadian National Collection (CNC) were examined and determined.

Abbreviations of names of collections referred to in the text are:

ACNS Agriculture and Agri-Food Canada, Kentville, Nova Scotia.
ACPE Agriculture and Agri-Food Canada, Charlottetown, Prince Edward Island.
CGMC Christopher G. Majka Collection, Halifax, Nova Scotia.
CNC Canadian National Collection, Ottawa, Ontario.
DHWC David H. Webster Collection, Kentville, Nova Scotia.
JOC Jeffrey Ogden Collection, Truro, Nova Scotia.
NSNR Nova Scotia Department of Natural Resources, Shubenacadie, Nova Scotia.
STFX Saint Francis Xavier University, Antigonish, Nova Scotia.

Results

Identification.—*Oulema melanopus* is a showy beetle with a black head, red pronotum and legs, and deep metallic blue elytra (Fig. 1). Such a color pattern is very uncommon in native Canadian leaf beetles; only *Gastrophysa polygoni* (Linnaeus), another Palearctic species introduced from Eurasia, looks superficially similar. The elytral punctation can be used to separate them easily as it comes in well-defined rows in *O. melanopus*, but it is completely confused in *G. polygoni*. The shape of the pronotum can also help to distinguish these two species, since the pronotum of *G. polygoni* possesses a well-formed bead on both sides whereas such a bead is not found in *O. melanopus*.

Distribution.—*Oulema melanopus* has now been found at a variety of sites in New Brunswick, Nova Scotia, and Prince Edward Island in the Maritime Provinces of Canada (Fig. 2). This is a first record for its presence in Prince Edward Island.

Locality records for the Maritime Provinces.—NEW BRUNSWICK: *Carleton Co.*: Hartland, 20.VII.1987, D.B. Finnamore, (on) grain, (3, CNC). *Victoria Co.*: Grand Falls, VII.1980, L.S. Thompson, (3, CNC). NOVA SCOTIA: *Antigonish Co.*: Antigonish, 14.V.1998, G. Merner, grassland, (1, STFX); Antigonish Landing, 14.V.1998, E.C. Roderick, grassy wetland, (1, STFX). *Colchester Co.*: Bible Hill, 13.V.1998, P. Van Wychen, (20, CNC), 30.VI.1997, L. Crozier (10, CNC); Clifton, 11.V.1998, L. Crozier, (10, CNC); Little Dyke, 4.IX.1996, Lorne Crozier; Masstown, 30,VI.1997, L. Crozier, (10, CNC); Shu-

Fig. 1. Habitus photograph of *Oulema melanopus*.

benacadie, 31.VII, 1997, J. Ogden, (1, JOC); Shubenacadie, 1.VIII, 1997, J. Ogden, (2, NSNR). *Halifax Co.*: Point Pleasant Park, 15.VI. 2001. C.G. Majka, grassy meadow, (1, CGMC); south-end Halifax, 6.VI.2001, C.G. Majka, open area, (1, CGMC). *Kings Co.*: New Minas, 20.V.2001, D.H. Webster, open

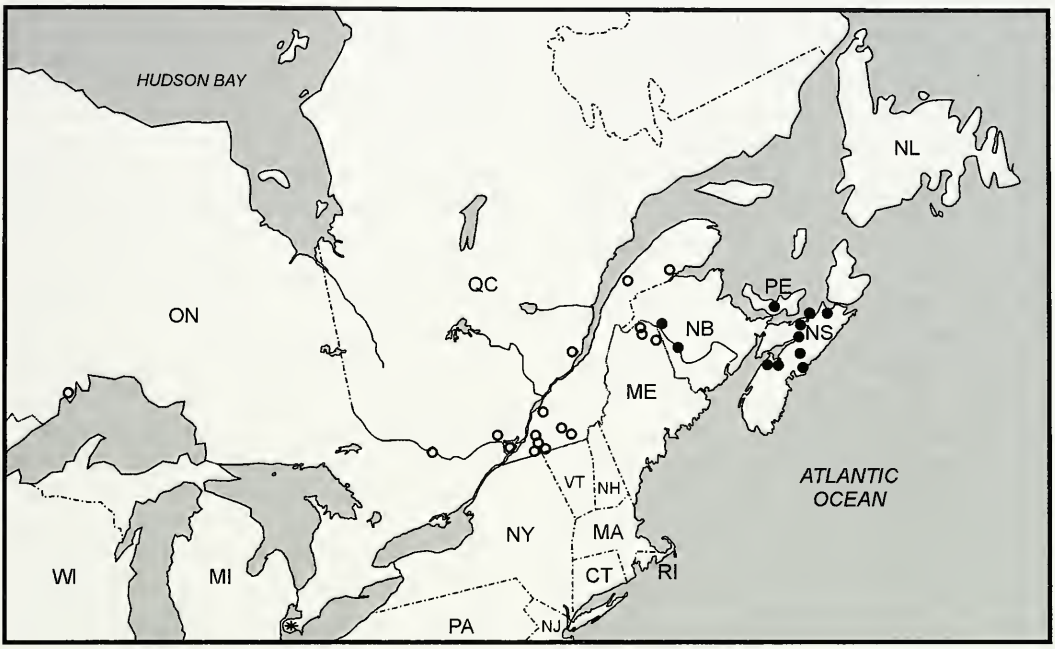

Fig. 2. Distribution of *Oulema melanopus* in the Maritime Provinces and adjacent regions. The asterisk (*) indicates the location of the first Canadian record; open circles indicate localities cited in the paper; closed circles indicate localities based on voucher specimens referred to in the paper.

woods, on *Daphne mezereum* L., (1, DHWC); Sheffield Mills, 17.VII.1996, L. Crosier, (2, CNC); Sheffield Mills, 15.X.1998, M. Trombley, (1, ACNS); Sheffield Mills, 21.V.1997, S. Rigby & C. O'Flaherty, (1, ACNS). *Pictou Co.*: Black River, 13.VII.1998. J. Ogden, (1, NSNR); Pictou Island, 14.VII.1998, J. Ogden, (1, NSNR). PRINCE EDWARD ISLAND: *Queens Co.*: Harrington, Harrington Farm, 2.VIII.1994, M.E.M. Smith, (on) winter wheat, (3, CNC; 3, ACPE).

Discussion

Oulema melanopus has been found in a variety of areas and habitats. Records from Grand Falls (NB), Hartland (NB), Harrington (PE), Sheffield Mills (NS), Shubenacadie (NS), and New Minas (NS) are in agricultural districts, frequently in or adjacent to agricultural sites. The specimens collected in Black River (NS) were along a small stream in a forested area not close to any agricultural areas. Of interest is the specimen collected on Pictou Island in the Northumberland Straits, 7.5 km from the nearest point of mainland Nova Scotia. This island is inhabited and parts are regularly harvested for hay production.

Also of interest are records from Halifax, an important transatlantic seaport. The specimen collected at Point Pleasant Park was less than 500 meters from the container terminal in the port area, while the specimen collected in south-end Halifax was immediately adjacent to the ravine along which the CNR railway lines run from the port. The port of Halifax has a very sizeable annual commerce of grain and related materials through the port facilities. *Oulema melanopus* does not feed on grain, nor is it likely to be moved in grain as adults generally die within about three weeks in such plant material. Adults do not survive long-term storage

in grain bins (Morrill et al. 1992), and it is known that beetles may be accidentally found in stored products (Campbell et al. 1989). However, *O. melanopus* adults may "hitch-hike" in solid wood packaging materials (e.g., crating), but interceptions are rare. Farm machinery, Christmas trees, fruit for consumption, and plants with or without soil also are known pathways of movement (Haynes and Gage 1981, Dobesberger 2002).

Point Pleasant Park and the port of Halifax are well-known sites for the introduction of a wide variety of adventive Coleoptera (Majka and Klimaszewski 2004). Majka and LeSage (2006) suggest that the road and rail corridors that lead from Halifax may have been responsible for the introduction and spread of the Palearctic leaf beetle, *Sphaeroderma testaceum* (Fabricius).

In the CLIMEX™ model of the potential distribution of *O. melanopus* generated by Olfert et al. (2004), most of the Maritime Provinces are indicated as being favorable for the establishment of the species with portions of Nova Scotia having EI (Ecoclimatic Index) values in the 35–40 range (values > 20 are considered favorable for establishment). *Oulema melanopus* is likely to continue to spread slowly by natural means throughout Canada. Host availability and climate change are likely to assure survival and establishment in new environments despite phytosanitary measures. Introduction of biological control agents and resistant cereal varieties would maintain cereal leaf beetle populations at or below economic thresholds.

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